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ABSTRACT

A program for natural forest management in developing countries consists of several integrated projects. Although aimed at establishing norms and criteria for natural forest management in Mata Atlantica (Atlantic Forest) in southern Brazil, the norms also apply to other types of tropical vegetation in order to ensure continuous economic exploitation of forest resources, maintain their genetic patrimony, and respect the delicate ecological balance. Emphasis is put on education and training programs for workers and technicians involved in forestry work. Both university programs and formal training projects are advocated. Training is essential in order to ensure maximum safety in forest management. This requires great changes in human behavior toward the forest. (Author/KC)

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Education and training in natural forest management

by Alceu Natal Longo

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Training Policies Branch
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Introduction

The programme described in this paper consists of several integrated projects and aims at establishing norms and criteria for natural forest management in "Mata Atlântica" (Atlantic Forest). However, the norms also apply to other types of tropical vegetation in order to ensure continuous economic exploitation of forest resources, maintain their genetic patrimony and, above all, respect the delicate ecological balance. Emphasis is put on education and training programmes for workers and technicians involved in forestry work in order to ensure maximum safety in forest management. This requires, above all, great change in man's behaviour towards the forest. The paper is an input to an environmental education and training project being undertaken by the Training Policies Branch of the ILO.

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I. Character of the area

The "Fazenda Faxinal" forest, owned by Catarinense de Seguros S.A. and exploited under contract by Florestal RH Ltd, covers an area of 2,208 hectares in the southern state of Santa Catarina, in the municipality of Blumenau.

The area being a part of the "Serra do Mar" (Coast Range) is hilly and situated at altitudes between 450 and 1,000 metres above sea level.

The vegetation of the forest is Pluvial Atlantic Slope Forest type, which presents two basic formations: the Faxinal, located at altitudes over 700 metres and the Atlantic Forest itself, at lower altitudes. The Atlantic Slope Forest covers about 70 per cent of the area of the "Fazenda Faxinal". Although in a region having a sub-tropical climate, the Atlantic Forest presents tropical characteristics and exhibits great vigour, high density, heterogeneity as to species of high and medium trees and bushes, and a high number of species of epiphytes. It also contains lianes and ligneous vines. The humidity conditions are almost identical to those found in the tropical forest, allowing for the existance of a dense heterogenous forest with a rich flora. In the area of the "Fazenda Faxinal", characterised by deep valleys and steep slopes, the higher stratum of the vegetation is formed by trees that reach 20 to 30 metres in height.

The "Faxinais" represent transitional forests between tropical forest and the Araucária (Brazilian Pine) Forest, which dominates in the Highlands. In these regions a rapid decrease in the number of tree species is observed. In the "Fazenda Faxinal", the vegetation known by the name of "faxinal" is a variation of the Atlantic Forest, resulting from the different types of much richer soils, the higher altitude and the less rough topography. Natural forest management at the "Fazenda" takes into account these variations which are very perceptible to men accustomed to the forest.

II. Description of natural forest management developed by Florestal RH Ltd[1]

The natural cover of the slopes of the "Serra do Mar" in Southern Brazil is, without doubt, the heterogenous original forest, the Atlantic Forest. This cover avoids degradation of the soil and guarantees the quality of the environment. The Atlantic Forest presents all the characteristics of the tropical forest, despite geographical proximity to sub-tropical regions (Veloso[2] and Klein[3]). Unfortunately, for cultural and economic reasons, natural resources have been abusively exploited which has forced the public authorities to undertake coercive measures to regulate its economic use. This has caused severe unemployment problems in the lumber sector, with negative social and political effects.

Although Brazilian tropical forests are extensive, not much work has yet been done in developing viable forms of forest management to replace the traditional techniques of forest exploitation.

Florestal RH Ltd, manages an area of 2,208 hectares of Atlantic Forest situated in the far south of the Municipality of Blumenau. It has been successfully exploiting it for over 15 years. It has created alternatives for preserving the remaining primary forest areas, for maintaining the original structure of the different species and ages of trees. This has made it possible to produce, on a permanent basis, forest products (lumber, palmetto and honey) without causing imbalances that might lead to the degradation of the environment.

Human interventations in the forest are extremely delicate. They require adequate information obtained from a detailed forest inventory and systematic technical staff training. Staff select trees for cutting, while considering the forest's dynamics. Natural forest management constantly rebuilds the forest by means of self-regeneration, combines different species and produces an economic surplus. It also maintains the forest's productive capacity, as it is increasingly made up of selected individual trees.

First of all, an inventory is made of all plants with a DCH (diameter at chest height) of ten centimetres. The individual trees destined for cutting are marked according to the information collected and analysed. The selection is made by two experienced staff, who evaluate each specimen's individual characteristics and its importance for maintaining a dynamic balance in the forest. Candidates for cutting are initially trees that present evidence of decadence (rachitic crowns, damaged stems), as well as those in unfavourable competition with specimens that are important for forestry (exceptional seed-producers, trees of extra high stature that favour the formation of uniform stems in their natural regeneration, rare specimens, individuals that act as shelter or nourishment for fauna, melliferous species and growing trees of high potential). Attention is also given to the original structure of the forest, with an eye on maintaining several species and their age distribution.

Tree cutting and log removal are vital for the future of the forest. Positive selection, preserving the robust individuals, even if adult or centennial, already implies reducing the felling of large trees. Individual trees designated for cutting usually carry reduced and weak crowns. This indicates a low growth rate. Furthermore, during the marking of trees for cutting, the impact of possible cutting upon the remaining individuals is considered. This helps preserve trees which would otherwise be designated for removal for their individual characteristics. This is the case of the "sapopema" (Sloaenea sp), which can seldom be cut due to the opening

that their crowns would cause in the canopy. They also shelter and breed birds and other animals. Also the removal of timber, usually done with the help of a hauling tractor and steel cables reaching up to 200 metres from the roads has to be severely controlled, so that the forest management team avoids causing damage to the stems of the remaining trees.

The plants with a larger basal area (the area of the stem at chest height) are not always the ones that are cut. A "canela-preta" (Ocotea catharinensis) with a smaller DCH may be cut, due to a severe defect on its stem in order to leave another tree, of older age and much greater bearing. This will help to maintain the genetic patrimony and the microclimate.

Experience has shown that the maximum cutting threshold cannot surpass 30 per cent of the total basal area. Otherwise, the introduction of rapidly growing species, but of low commercial value, would be favoured. Their role is to heal rapidly the clearings opened by the natural mortality of the large trees, later creating environmental conditions for the germination and growth of the primary species, which prevail in the virgin forest[4]. Forests return to their basal area of climatic climax within nine years, similar to the original forest, but are composed of individual trees having better formed stems and crowns and a relatively high growth rate.

The forest's growth rate has been determined from measurements made at one year intervals in a primary forest stand, composed of 172 individual trees[5]. With 47 species of trees, besides the palmetto tree (Euterpe edulis), it is representative of the diversity of the Atlantic Forest, although located in an area of relatively poor and dry land. The stems have modest dimensions. The trees have been classified by crown type, where class 3 stands for exuberant crowns, 2, normal crowns and 1, weak ones. Good knowledge of species is required of the evaluator, since, for example, the exuberant crown of a "canela burra" (Dcotea Kuhlmanii) is much less voluminous than the normal crown of a "caxeta" (Chrysophylum viride), although both have the same DCH. Yearly increases in volume of 3.8 per cent for the exuberant, 2.8 per cent for the normal and 0.5 per cent for the weak crowns have been obtained, suggesting that tree growth is a function of the quality of their crowns. This conforms with the selection criteria employed in natural forest management, which eliminates the trees having weak crowns and increases the population of normal and exuberant crowns, in order to raise the average growth rate of the forest. The opening of clearings in the forest by cutting trees is minimised, as this opening is a function of the volume of the crown.

The annual average increase of the basal area, in its turn, is a function of the diameter of the stem (DCH), arranged by DCH categories. According to a forest inventory carried out for the total area of the property, the average basal area per hectare is 26.24 square metres for the original forest. Using the volumetric equation

VOL = -0.00422525 + 0. 00005278 * DCH2 * ALT

where DCH means the diameter (centimetres) at chest height and ALT (metres) the estimated height of the useful stem, the yearly yield per hectare is 3.49 cubic metres. This yield is made possible through natural forest management on the Atlantic Slope Forest which makes it possible to maintain a continuous production flow. The removal of 34 cubic metres of carefully selected timber in one hectare corresponds to 31 per cent of the average volume of 110 cubic metres measured in the inventory of the entire property. After nine years, the initial supply is reached again. The forest cannot surpass this limit given the characteristics of its climate, soil and tree species. The limitating factor is the basal area. As selection favours the height of the stems of each species, an even higher volume than for the untouched forest may be obtained. The loss of nutrients is minimal since the timber of the stem is almost exclusively composed of carbon, oxygen and hydrogen chains absorbed from the atmosphere. The other nutrients are concentrated in leaves and branches of the crown, which are reincorporated into the biosystem. This ensures the continuity of forest reproduction.

The palmetto-tree (Euterpe edulis) plays an important role in forest management. This is because its crown reacts very quickly to increasing exposure to light after the forest has been trimmed. Also, due to its low basal area, it is possible to increase the density of this species significantly before the forest reaches its climatic climax again. The palmetto-tree can be cut every three years, the time needed for young stock to reach maturity. Florestal RH Ltd uses a specific procedure for managing this native palm. The average seedling stock per hectare is doubled every ten years to an average of six thousand. This produces a reserve of individuals ready to benefit from reduced competition inside the forest. According to our experience, the production capacity in the palmetto-tree managed areas is 50 palm-hearts per hectare and year, with an average yield of 0.705 kilograms per palm-heart. This is confirmed by research done by the Federal University of Santa Catarina (UFSC).

Multiple use of the forest, including production of high quality honey generates higher incomes per area. In 1990 beehives had a harvest of 3,500 kilogrammes of honey. The production potential could be above 6,000 kilogrammes with improved bee management and construction of roads in inaccessible places. An increase in the production capacity of the apicultural feeding ground is also expected as a consequence of natural forest management which can also promote more exuberant crowns and, therefore, more intense blossoming.

Florestal RH established a guard service to protect the palmetto-groves from theft. The beehives are also victims of looting if unprotected. The guards have put an end to constant and indiscriminate hunting, which is still a habit of the neighbouring communities. The original fauna of the region is now thriving. Large predators like the puma (Felis Concolor) which need a complex food chain for their subsistance are increasingly common.

III. The economic feasibility of natural forest management

The feasibility of managing tropical forests economically is possible under certain premises. Production costs tend to be higher than under predatory exploitation. This challenge can be met by complementary production of palmetto and honey. Forest product prices can accommodate additional costs of rational forest management only if competition from traditional predatory low-cost harvesting is eliminated.

Brazil is living through a historic period. The Federal Government is determined to preserve the forests and the State Government of Santa Catarina is intent on reducing fiscal criminality. These policies create, for the first time, the conditions for increasing forest product prices so that they cover the social cost of natural management. Lumberers, now threatened by an end to the exploitation of native forests, are willing to adopt more sustainable forest management practices and produce less, but continuously. The depletion of forests in Southern Brazil, once rich in noble and hard timber, also increases prices on these products. Prices of alternative produce from Paraguay and the north of Brazil must cover the cost of highway transportation.

Intensive exploitation through natural forest management covers a net area of 1,820 hectares. The removal of the annual yield (3.49 cubic metres per hectare) at market prices for logs, was presumed. The production of palmettos was restricted to 1,106 hectares, even though the palmetto-groves are expanding areas located at higher altitudes (above 700 metres). For apiculture the entire property was considered. Cash payment for labour, vehicle maintenance, road building and some other costs have been projected using the company's income and expense accounts. After calculating the present value of the yearly cashflow in hard currency (US$) for one year and using an annual discount rate of 6 per cent, a net return of US$ 292,957 per year was reached. This figure demonstrates the economic feasibility of natural forest management.

We assumed continuity of production and expanded the time horizon under the assumption of a constant net annual return (R1 = R2 = ...). Knowing that the capitalised value of a constant flow is equal to

$$R1 / (1+i) + R2 / (1+i) + \ldots = R / i,$$

where "i" is the discount rate used (in this case, the reasonable 6 per cent a year in hard currency) and R=R1=R2=...,the value of the land and the forests that cover it equals C = R/i+R0 = US$ 292,957 / 0.06 + 292,957 = US$ 5,175,568, where we added R0 once the lumber stock generates net income at the starting moment (0).

The sensitivity of the net income to an increase in real timber prices must be taken into account, since the country, and especially the civil construction industry, are going through a strong recession. A price increase of 10 per cent, brings the value to US$ 5,822,604. This equals approximately the estimated market value of the land and the value of the lumber and the palmetto stock. This means that continuous production using natural forest management practices, although incurring additional social costs such as protecting the forest's biodiversity, achieves the same economic return in the long run as predatory and short sighted forest exploitation.

The activity generates approximately 20 direct jobs. As there are 150,000 hectares of Atlantic Forest in the State, 1,356 permanent jobs in the

primary sector could be created as secondary forests could also be an important source of forest products. The dissemination of natural forest management could be a significant factor in promoting employment in rural areas.

IV. Education and training in natural forest management

Natural forest management is relatively labour intensive, but requires skillful and dedicated workers and technicians who can intervene in the tropical forest's complex biotic system. This demands much experience and training.

Field training is done by the so-called "wood team", composed of the team leader, the chain saw operator, the tractor operator and the cable operator. At Florestal RH Ltd., the team leader reports to the forester who is a director-partner of the company and who audits the quality of work done during regular inspections at the management stands.

The less qualified work is done by the cable operator. He is responsible for forest regeneration and for protecting the remaining trees from damage when hauling the timber with the tractor. The team leader must supervise the operator closely during the learning process. He must also enter the numbers of trees felled on the log production spreadsheet. The cubing of the logs is a responsibility of the team leader and is executed by the cable operator as soon as he demonstrates ability and exactitude. The writing of forestal bills of lading and fiscal notes during log loading onto trucks demands skill in using calculators. All this work teaches the worker to care about the plants. He learns to recognise the different species and to respect the forest.

The chain saw operator needs specific operating and maintenance skills which may be provided by equipment suppliers. He must have a perception of space, in order to be able to cut trees so that the least possible damage is caused to the forest. If a large tree is cut it will open a clearing that will jeopardise the production of noble and hard timber for decades. The filling up of the clearing is done by soft timber species, of less commercial value. This practice modifies the structure of the forest. Replacing young damaged plants by germinating new seeds takes many years, even if soft species are used. The training and supervision of the chain saw operator by the team leader must be intense, until the operator gains the required confidence. He must be able to decide not to cut a tree even if it had been marked for felling, if the felling would have undesirable consequences. Constant inspection by the forester in the managed area is necessary in order to guarantee the quality of the job.

The work of the tractor operator is above all mechanical. However, he must pay attention to the movements of the equipment and not damage the bark of the trees and he must help the cable operator with the hauling of the logs. He is also given field training for operating and maintaining tractors.

The cable operator and the chain operator join the team leader in making a forest inventory. This is usually done on rainy days, when extraction work cannot be carried out. The team leader, an experienced woodsman, identifies the species of each tree. The circumference at chest height, an estimate of the stem's usable height and the evaluation of the crown are registered on a spreadsheet[6]. The gathering of such information is in itself a training procedure for the chain saw operator and the cable operator. The recognition of over 80 forest species at different stages of development requires years of working in the forest.

The marking of trees designated for felling is carried out jointly by the forest management team leader and the forester. The latter already disposes of processed information about the structure of the area from the inventory. Ecological limitations make it possible to remove up to 30 per cent of the basal area (the

addition of the areas of the stems at chest height). Only trees with low increase rates (related to the quality of the crowns) and with ill-formed stems or affected by some disease or insect are removed. Efforts are made to preserve the primary species of the forest. Many other aspects are considered, e.g. the need for sufficient regeneration, the damage caused by felling to animals' nests, the preservation of seed-bearers and the genetic patrimony. This is delicate work, which requires an accurate vision of the forest's dynamics and a perception of how it will react in the long run when individual trees are cut. The decision-making demands that the team leader constantly updates his techniques and objectives of natural forest management.

The forester inspects and samples the measurements carried out by the team. For training purposes, the chain saw operator or the cable operator may participate in selecting the trees.

Training can also be given to teams using animal traction in forest harvesting. Such teams (a leader and a helper) can work in areas not accessible to mechanical extraction. The leader must be a chain saw operator and have previously performed all the tasks of a cable operator. The team carries out the inventory, the felling and the removal of the logs. Quality control is done by the team leader. As production is only one third of that of mechanised teams, the marking of the trees can be done by the head of the mechanised team, with some help from the head of the animal traction team. The forester only carries out the inspection of the work already done.

There is also the palmetto team, which extracts the edible part (the so-called palmetto) obtained through the cutting of the palmetto-tree. The team leader is trained by the forester to follow cutting criteria that increase the density of the palmetto-trees in the forest and improve its genetic quality. Exceptional seed-bearers and individual adult trees necessary for increasing density must be preserved . The team leader must exercise judgement when palmetto-trees are designated for cutting, in order not to reduce the productive potential of the palmetto-groves. Experience suggests that regular supervision of the team remains essential because the palmetto reapers tend to cut down the specimens giving higher yields, even when their pay is not related to production volume.

Since the forest is used for multiple purposes, the forester also needs the services of an apiculturist. Florestal RH Ltd controls the beehives and honey production in order to select highly productive queen bees. Parallel to the training programmes offered by apiculture promoting agencies, the forester must regularly accompany the beekeeper and discuss the details of the beehives in order to maintain and improve this activity, which adds up to a significant share of the total income of the enterprise.

Last but not least, there is the forest guards team. A new guard has to learn all the daily routines for protection against palmetto thieves and hunters. Accompanied by trained dogs, they have to learn to register tracks of invaders, to follow and seize the transgressors. The guards also provide information for the fauna inventory, about seed production and apicultural blossoming. They must, therefore, have the same motivation to preserve the forest and its inhabitants as other working groups.

At Florestal RH the forester gains experience and knowledge during the process of selecting trees for felling, which is carried out with the help of an experienced woodsman, and when inspecting and analysing the inventory and cutting data. The forester is continually making new observations that will influence future management decisions. Contacts with specialists who have visited the property have contributed to improved exploitation.

Florestal RH has also developed an expert system for the forester's self-development. Its elements are the tree cutting criteria or rules[7]. One of the rules for cutting palmetto-trees selectively could be exemplified as follows:

A palmetto-tree can be cut if it is located on a half-slope, is not an exceptional seed-bearer, has at least three seedlings at the range of its crown, has at least one young palmetto-tree under its influence, its removal will not excessively stimulate weeds and there is a reasonable population of seed-bearers in the stand.

Imagining a set of, say, 15 such rules (considering sites other than half-slope, competition with other adult palmetto-trees, existence of adolescent palmetto-trees in its area of influence, different luminosity degrees inside the forest), an idea can be made of the number of parameters a palmetto-cutter must consider when making his decision to cut the tree. The rules, if regularly disseminated, are an important training instrument for the palmetto-cutter. Also, the expert system is not only a depository of the forester's experience, but also material that can be improved by incorporating new knowledge and tools. The system has been developed for the foresters in palmetto management but can be extended to natural management of the forest as a whole.

A well trained forestry management team and an experienced forester can carry out natural management without numbering all trees as is presently done at Florestal RH Ltd. It is perfectly possible to carry out natural forest management on a larger scale in the Atlantic Forest, or even in the Amazon Forest, with higher labour productivity. But the team, from the cable operator to the forester, must be properly trained and kept up-to-date with new knowledge and techniques.

A. Training of university students

Students from the biological sciences course at FURB do forest management work at Fazenda Faxinal according to an agreement between University and Florestal RH Ltd. The aim is to develop the student's familiarity with the tropical forest and the management criteria used in exploiting it. The students are selected according to academic performance and after an interview with their professor who determines their suitability for forest work.

After each phase of field work, repeated every 15 days, the collected data and information are analysed and discussed by the group and their professors, in a process of continuous evaluation.

Field work has improved the academic performance of the participating students and widened their understanding of the relationship between man and forest resources.

B. Formal training project

To complement the field training, the Foundation University of Blumenau (FURB) is interested in developing theoretical teaching programmes. First, a correspondence course is being considered for training young forestry workers to carry out more elemental forestry tasks, e.g., measuring and calculating a stand in the woods, and identifying systematically the different species of arboreal vegetation. Secondly a two month course is being planned for more advanced students of the Natural Sciences course and for professionals in this field, in order to present the main objectives, experiences and techniques of natural forest management. This course intends to prepare future faculty for the foresters or forestry technicians courses, for which the University already has physical facilities in the nearby municipality of Ibirama. The practical part of these courses will be developed on the property where Florestal RH Ltd. carries out its Natural Forest Management activity.

V. Conclusion

The work so far developed shows that natural management of forest resources at "Fazenda Faxinal" is a coherent alternative and consists of the exploitation of tropical forest that gives economic and social return, and, above all, is a means of assuring the biodiversity and the ecological balance of these ecosystems. This can only be carried out by a well trained and coordinated team of forestry technicians and workers.

Notes

1. The description of natural management, as well as the analysis of economic feasibility were borrowed from the project elaborated by Florestal Rh Ltd., called "Projeto de Pesquisa em Mata Atlântica" (Research Project in the Atlantic Forest), forwarded to official agencies, such as the "Secretaria de Meio Ambiente" (Environment Secretariat) - SEMAM (Brazil) ant the "Gesellschaft für Technische Zusammenarbeit" (Agency for Technical Cooperation) - GTZ (Germany).

2. Veloso, H. P. And Klein, R. M., *As comunidates e as associações vegetais de Mata Pluvial Sul do Brasil* (Vegetal Communities and Associations of the Southern Brazil Pluvial Forest), Sellowia 8:81-235, Herbário Barbosa Rodriges, Itajaí, 1959.

3. Klein, R. M., *Constribuições ao Conhecimento da Flora e da Vegetação do Vale do Itajaí* (Contribution to the Knowledge of Flora and Vegetation on the ITajaí Valley), Solowia 31 and 32, Herbáreo Barbosa Rodriges, Itajaí, 1982.

4. Hubbell, S. P. And Foster, R. B. "Canopy Gaps and the Dynamics of a Neotropical Forest", in *The Dynamics of a Neotropical Forest.*

5. Tables on forest growth rate are available from the Training Policies Branch of the ILO, 4 rte. des Morillons, CH-1211, Geneva 22.

6. Tables on stem diameter are available for interested readers from the Training Policies Branch of the ILO.

7. Mr. Klaus G. Hering, managing partner of Forestal RH Ltd, helped in the elaboration of this item and particularly in outlining the expert system.